ELECTRON TEMPERATURE IN ELECTRODELESS DISCHARGE SUBJECTED TO A TRANSVERSE MAGNETIC FIELD

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ABSTRACT. Values of electron temperature in molecular gases subjected to electrodeless discharge have been obtained from mobility and its variation with pressure. The apparent discrepancy with the published data is shown in two cases, namely, effect of magnetic field and high value of X/p.

The electron temperature in gaseous discharges has been measured by a number of workers (Seeliger and Hirchert, 1931; Killian, 1930; Sommermeyer, 1934, Druyvesteyn, 1933) with different discharge currents and gas pressures. In view of the fact that almost all the data, available in the literature, refer to the rare gases, and very few to molecular gases, we report here some results of measurement of the electron temperature in molecular gases within a limited range of pressures The values of the electronic mobility as were reported (Goswami, 1958) in electrodeless discharge subjected to a magnetic field, have been used in evaluating the electron temperature. The values of electron temperature may be determined from mobility and its variation with pressure from a simple relation derived below. Starting with the relation

RESULTS AND DISCUSSION

$$\frac{1}{2}\,mc^2 = \frac{3}{2}\,KT_e \qquad \ldots\ (1)$$

we can write

$$mu^2 = KT_e \qquad \ldots\ (2)$$

where $c^2 = u^2 + v^2 + w^2$, the symbols having their usual significance.

In a gas subjected to an electrical discharge and in thermal equilibrium we can write (Huxley, 1957) for the drift velocity

$$W = \frac{2}{3}\cdot\frac{X.e}{m}\cdot\frac{l}{\bar{c}} = \mu_e X \qquad \ldots\ (3)$$

and

$$\bar{u} = \frac{\bar{c}}{1.6} \qquad \ldots\ (4)$$

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where $\bar{c}$ = mean velocity; l = mean free path: X = electric field and μ_e = electronic mobility.

From (2), (3) and (4) we can write

$$T_e = \frac{l^2}{\mu_e^2} \times 3.35 \times 10^{18} \qquad \ldots \quad (5)$$

Eqn.(5) can be used to ascertain the variation of T_e with pressure by using the values of electronic mobility determined earlier (Deb and Goswami, 1956; Goswami,

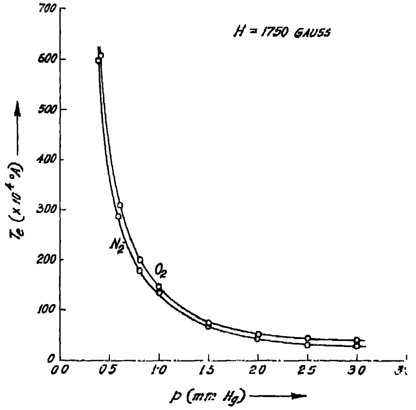

Fig. 1

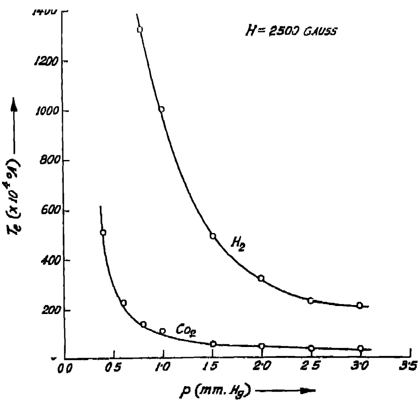

Fig. 2

1958). Standard values of l at 1 mm. Hg for such gases are taken from Loeb (1939) and those corresponding to other pressures are found out from the relation pl = constant. The results are shown graphically in figures 1 and 2. The qualitative variation of T_e with p is as expected and in conformity with the data given in Handbuch der Physik (1953), and Guthrie and Wakerling (1949). Quantitatively, however, it may appear that the results obtained here are one order of magnitude higher. This apparent discrepancy can, however, be traced to two causes. Firstly, T_e depends on H markedly and it increases apparently with increasing magnetic field (Figure 3). T_e as obtained here is thus a bit higher,

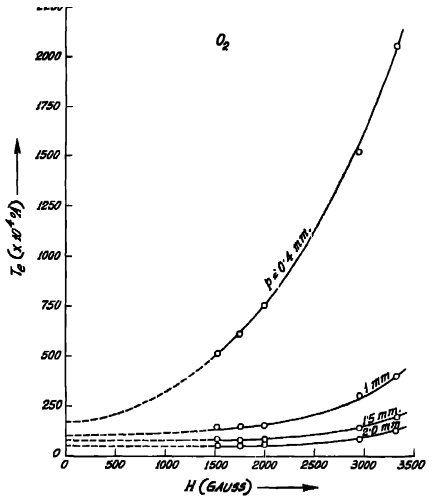

Fig. 3

as measurements are made in the presence of a fairly strong magnetic field. Secondly, in our experimental set-up the value of X/p was high ($\doteq$ 1000). In order to illustrate the possible contribution due to these two causes we proceed as follows. Values of T_e for a given gas and discharge tube are plotted against magnetic field with pressure as the parameter and the corrected value is obtained by extrapolation to zero value of H (figure 3) The extrapolated values thus determined are plotted as a function of X/p (Figure 4). This latter curve shows that T_e increases with X/p. From this trend of variation of T_e as observed in figure

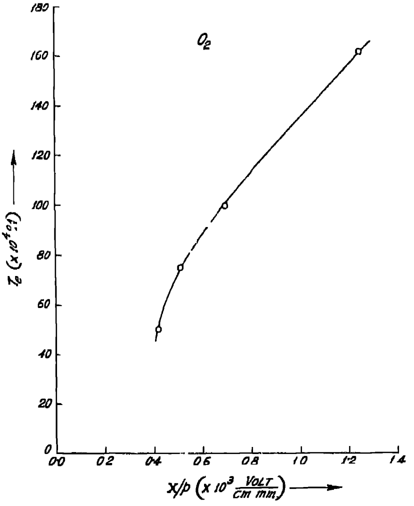

Fig. 4

4 it is easily seen that the experimental values may be higher by an order due to the two causes mentioned above, viz., effect of magnetic field and high X/p value.

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